Assembly
and
Operation
of the

HEATHKIT®

2-METER
FM TRANSCEIVER

MODEL HW-202

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

OPERATION

CONTROLS AND CONNECTIONS

Refer to Figure 3-1 (fold-out from Page 100) for the location and functions of front and rear panel controls, connections, and adjustment access points.

Speaker

If an external 4 ohm speaker is used, connect it to the rear panel socket and push the rear panel speaker switch to EXT. If you use the built-in speaker, make sure the rear panel speaker switch is pushed to INT.

Microphone

Use only the microphone supplied with your Transceiver, or a microphone with a very flat response. Connect it to the front panel connector and make sure the connector thumbnut is tight.

Depress the microphone switch to activate the transmit circuits; release the switch to receive.

Signal Meter

The front panel meter shows relative transmitted signal strength and relative received signal strength.

Squelch

To adjust the squelch control, turn it fully counterclockwise. Turn the Transceiver on and set the VOLUME control so background noise is heard at average volume. Then turn the SQUELCH control knob clockwise until the noise disappears. Setting the SQUELCH further clockwise requires a stronger received signal to break the squelch.

POWER SUPPLY

A DC voltage between 12.6 volts and 16 volts will operate the Transceiver. The voltage can be secured from the AC-operated supply or direct from a "12-volt" DC system, such as an automobile battery. The supply must have a negative ground and be capable of at least 2.2 amperes output. For fixed station use, the Heath Company has designed an AC-operated power supply specifically for this Transceiver.

Should you operate the Transceiver on a portable battery pack, removing the pilot lamp will lower the current drain by 70 mA. The squelched receiver will then draw approximately 70 mA from the battery pack.

CAUTION: Before you connect your Transceiver to a mobile "12-volt" power source, check the voltage at the battery with the engine running above a fast idle. The voltage MUST NOT exceed 16 volts or the Transceiver may be damaged.

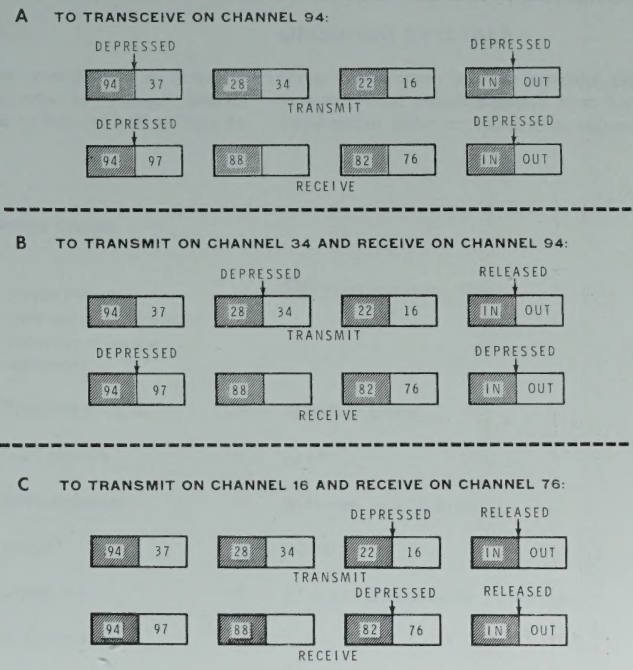


Figure 3-2

TO TRANSCEIVE

1. Turn the Transceiver on and adjust the volume control about half way open.

2. Push in the Channel Selector buttons for the desired transmit and receive frequencies. NEVER have two channel selector buttons in the same row pushed in at the same time.

3. Position each IN-OUT button so its position matches the background color of the label for the desired channel in its row. If the desired channel number has a black background, then the IN-OUT button should be pushed IN. If the desired channel number has a silver background, the IN-OUT button should be OUT. See Figure 3-2 for examples.

4. Adjust the SQUELCH control, if necessary.

5. Press the microphone button in to transmit; release it to receive.

COMMON REPEATER FREQUENCIES

If you contemplate taking a trip, an inspection of the A.R.R.L. Repeater Directory may list the repeater frequencies for areas you will visit or pass through. As a matter of interest, if your Transceiver is equipped with crystals for the following repeater channels, you can work into more than 300 repeaters in the U.S. and Canada in the 146 to 147 MHz range.

Transmit	Receive
94	94
28	88
22	82
16	76
34	

INSTALLING CRYSTALS

To select the crystal socket corresponding to a specific channel-selector pushbutton, refer to "Channel Selector Pushbuttons and Labels" and to Pictorial 5-20 on Page 91.

ORDERING CRYSTALS

Crystals, in addition to those furnished, should be ordered through normal crystal suppliers. Note that the following specifications differ for transmitting and receiving crystals:

Transmitter Crystals

Crystal frequency (operates on fundamental frequency at parallel resonance)	=	$\frac{\text{Operating frequency (MHz)}}{24}$
Tolerance at 25°C	=	.0025% or better.
Load capacity	=	23 pF.
Series resistance	=	40 Ω max. (−30°C to 60°C).
Holder*	=	HC-25U.
Crystal cut	=	AT cut at approximately + 2 minutes.

Receiver Crystals

Crystal frequency (third overtone at series resonance)	=	$\frac{\text{Operating frequency (MHz)} - 10.7 \text{ MHz.}}{3}$
Tolerance at 25°C	=	.002% or better.
Load capacitance	=	None.
Series resistance	=	40 Ω max. (−30°C to 60°C).
Holder*	=	HC-25U.

*Holder pin size	=	.040" dia.
Holder pin spacing	=	.192".

REGULATOR-HASH FILTER CIRCUIT BOARD

PARTS LIST

Remove the parts from pack #1 and check each part against the following list. The key numbers correspond to the numbers on the Parts Pictorial (fold-out from Page 11).

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
RESISTORS, 1/2-Watt				
A1	1-62	1	51 Ω (green-brown-black-gold)	.15
A1	1-7	1	680 Ω (blue-gray-brown)	.15
CAPACITORS				
Disc				
A2	21-17	2	270 pF	.15
A2	21-143	2	.05 μF	.30
A2	21-95	1	.1 μF	.25
Electrolytic				
A3	25-145	1	25 μF, 30V	.75
A3	25-146	1	100 μF, 30V	.70
DIODES-TRANSISTOR				
A4	56-57	1	1N716A zener diode (violet-brown-blue-brown)	1.00
A4	57-27	1	1N2071 diode	.75
A5	417-175	1	2N5294 transistor	1.45

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
HARDWARE				
B1	250-52	1	4-40 x 1/4" screw	.05
B2	252-15	1	4-40 nut	.05
B3	254-9	1	#4 lockwasher	.05
B4	250-56	1	6-32 x 1/4" screw	.05
B5	252-3	1	6-32 nut	.05
B6	254-1	1	#6 lockwasher	.05
MISCELLANEOUS				
C1	45-85	1	RF choke	1.15
C2	412-39	1	Lamp, #756R	.90
C3	434-88	1	Lamp socket	.15

PARTS FROM PACK #5 (parts in the shipping carton):

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
		1	Wire bundle	

NOTE: Remove the wire bundle. Cut off lengths when you are directed by the assembly steps in the various sections of this Manual.

Consists of:

	340-3	*1*	*Bare wire*	.05
	343-12	*1*	*RG-174/U coaxial cable*	.10/ft
	343-15	*1*	*Shielded cable*	.10/ft
	344-15	*1*	*Large black stranded wire*	.05/ft
	344-90	*1*	*Small black stranded wire*	.05/ft
	344-52	*1*	*Solid red wire*	.05/ft
	344-92	*1*	*Small red stranded wire*	.05/ft
	344-16	*1*	*Large red stranded wire*	.05/ft
	346-20	*1*	*Small sleeving (heat shrinkable)*	.20/ft
	346-35	*1*	*Large sleeving*	.15/ft
	348-2	*1*	*Magnet wire (enameled)*	.10/ft
	85-1247-1	1	Printed circuit board	2.80
	134-847	1	Wire harness	5.00
C4	490-5	1	Nut starter	.15
	391-34	1	Blue and white identification label	.15
	597-260	1	Parts Order Form	
	597-308	1	Kit Builders Guide	
		1	Assembly manual (See front cover for part number.)	2.00
			Solder (Additional 3' rolls of solder, #331-6, can be ordered for 25 cents each.)	

NOTE: See Page 112 for "Replacement Parts and Price Information."

POWER AMPLIFIER CIRCUIT BOARD

PARTS LIST

Remove the parts from pack #2 and check each part against the following list. The key numbers correspond to the numbers on the Parts Pictorial (fold-out from Page 12).

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
RESISTOR				
A1	1-32-12	1	100 kΩ, 1/4-watt (brown-black-yellow)	.15
CAPACITORS				
Disc				
A2	21-169	2	6 pF	.15
A2	21-3	1	10 pF	.15
A2	21-9	1	100 pF	.15
A2	21-11	1	150 pF	.15
A2	21-17	9	270 pF	.15
A2	21-154	1	.0051 μF	.15
Electrolytic				
A3	25-220	1	10 μF (tantalum)	.70
Other				
A4	28-3	1	.56 pF phenolic (green-blue-gray-silver)	.15
A5	31-54	1	4-40 pF trimmer	.55
A5	31-52	4	8-60 pF trimmer	.60

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
DIODE-TRANSISTORS				
B1	56-56	1	1N4149 diode	.30
B2	417-804	1	2N5589 or CTC B3-12 transistor	9.60
B2	417-803	1	2N5590 or CTC B12-12 transistor	13.50
HARDWARE				
#4 Hardware				
C1	250-321	3	4-40 x 1/8" screw	.05
C2	250-163	3	4-40 x 5/16" self-tapping screw	.05
#6 Hardware				
C3	250-56	10	6-32 x 1/4" screw	.05
C4	250-106	4	6-32 x 3/8" self-tapping screw	.05

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
#6 Hardware (cont'd.)				
C5	250-1157	10	6-32 x 1/4" stud	.15
C6	252-3	6	6-32 nut	.05
C7	254-1	16	#6 lockwasher	.05
C8	252-22	2	6-32 Speed Nut*	.05
Other				
C9	252-4	2	8-32 nut	.05
C10	252-181	2	8-32 shoulder nut	.25
CONNECTORS				
D1	432-120	4	PCB connector	.15
D2	432-121	1	PCB pin	.15
D3	432-152	9	Female connector	.15
D4	432-184	1	9-pin receptical housing	.20
D5	434-174	1	Dual phono socket	.15
D6	438-4	2	Phono plug	.15

*Registered Trademark, Tinnerman Co.

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
MISCELLANEOUS				
E1	45-38	2	.295 μH RF choke	1.00
E2	60-80	1	Slide switch	.55
E3	69-72	1	Relay	6.10
E4	260-16	1	Alligator clip	.10
E5	352-13	1	Silicone grease	.25
E6	475-10	8	Ferrite bead	.15
	490-168	1	1/4" x 5/16" end wrench	.25
PARTS FROM PACK #5				
	85-1661-1	1	Printed circuit board	3.30
F1	203-1466	1	Rear panel	1.95
F2	205-1425-1	1	Panel plate	1.30
F3	490-1	1	Alignment tool	.15

NOTE: See Page 112 for "Replacement Parts and Price Information."

RECEIVER CIRCUIT BOARD

PARTS LIST

Remove the parts from pack #3 and check each part against the following list. The key numbers correspond to the numbers on the Parts Pictorial (fold-out from Page 29).

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
RESISTORS				
A1	1-49	1	22 Ω (red-red-black)	.15
A1	1-1	1	47 Ω (yellow-violet-black)	.15
A1	1-3	10	100 Ω (brown-black-brown)	.15
A1	1-45	2	220 Ω (red-red-brown)	.15
A1	1-42	3	270 Ω (red-violet-brown)	.15
A1	1-4	1	330 Ω (orange-orange-brown)	.15
A1	1-6	3	470 Ω (yellow-violet-brown)	.15
A1	1-63	1	510 Ω, 5% (green-brown-brown-gold)	.15
A1	1-95	1	560 Ω, 5% (green-blue-brown-gold)	.15
A1	1-9	7	1000 Ω (brown-black-red)	.15
A1	1-10	6	1200 Ω (brown-red-red)	.15
A1	1-11	1	1500 Ω (brown-green-red)	.15
A1	1-44	3	2200 Ω (red-red-red)	.15
A1	1-13	1	2700 Ω (red-violet-red)	.15
A1	1-14	3	3300 Ω (orange-orange-red)	.15
A1	1-16	4	4700 Ω (yellow-violet-red)	.15
Resistors (cont'd.)				
A1	1-64	1	5100 Ω, 5% (green-brown-red-gold)	.15
A1	1-19	2	6800 Ω (blue-gray-red)	.15
A1	1-73	1	8200 Ω (gray-red-red)	.15
A1	1-20	9	10 kΩ (brown-black-orange)	.15
A1	1-21	2	15 kΩ (brown-green-orange)	.15
A1	1-58	3	22 kΩ, 5% (red-red-orange-gold)	.15
A1	1-23	2	27 kΩ (red-violet-orange)	.15
A1	1-24	2	33 kΩ (orange-orange-orange)	.15
A1	1-88	1	36 kΩ (orange-blue-orange)	.15
A1	1-25	4	47 kΩ (yellow-violet-orange)	.15
A1	1-102	1	82 kΩ (gray-red-orange)	.15
A1	1-26	9	100 kΩ (brown-black-yellow)	.15
A1	1-121	2	120 kΩ (brown-red-yellow)	.15
CAPACITORS				
Mica				
A2	20-101	1	47 pF	.25
A2	20-161	1	68 pF	.45
A2	20-103	1	150 pF	.25

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
Capacitors (cont'd.)				
Disc				
A3	21-33	1	3.3 pF	.15
A3	21-78	5	5 pF	.15
A3	21-3	3	10 pF	.15
A3	21-111	1	15 pF	.15
A3	21-51	6	20 pF	.15
A3	21-7	3	33 pF	.15
A3	21-11	2	150 pF	.15
A3	21-17	12	270 pF	.15
A3	21-56	9	470 pF	.15
A3	21-43	5	.001 μF	.15
A3	21-154	1	.0051 μF	.15
A3	21-47	3	.01 μF	.15
A3	21-82	1	.02 μF	.15
A3	21-143	9	.05 μF	.30
A3	21-95	16	.1 μF	.25
Electrolytic				
A4	25-200	2	.68 μF tantalum	.75
A4	25-221	1	2.2 μF tantalum	.60
A5	25-115	4	10 μF (MFD)	.60
A5	25-117	3	100 μF (MFD)	.75
Phenolic				
A6	28-3	4	.56 pF (green-blue-gray-silver)	.15
A6	28-2	1	1 pF (brown-black-white-silver)	.15

COILS-CHOKES-TRANSFORMERS

B1	40-1630	6	.975 μF coil	1.00
B2	40-1614	2	.16 μH coil	1.00
B3	40-1625	1	.16 μH tapped coil	1.00
B3	40-1613	1	.15 μH tapped coil	1.00
B4	40-1615	1	.4 μH coil	1.00
B4	40-1617	1	.16 μH coil	1.00
B4	52-118	1	IF transformer	.90
B4	52-154	1	IF transformer	1.05
B4	52-165	1	IF transformer	1.00
B4	52-166	1	IF transformer	1.00
B5	40-1616	1	.15 μH coil	1.00
B6	45-39	1	4.65 μH choke	1.00
B7	45-83	1	1 mH choke	1.00
B8	45-82	1	350 μH choke	1.00
B9	52-160	1	IF transformer	1.00

DIODES

C1	56-26	4	1N191 (brown-white-brown)	.40
C1	56-56	6	1N4149	.30
C1	56-73	1	MZ2360	.55
C1	56-74	1	MZ2362	1.00

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each

TRANSISTORS-INTEGRATED CIRCUIT

NOTE: Transistors and integrated circuits are marked for identification in one of the following four ways.

1. Part number.
2. Type number.
3. Part number and type number.
4. Part number with a type number other than the one listed.

C2	417-91	7	2N5232A transistor	.85
C2	417-201	3	X29A829 transistor	.50
C3	417-94	1	2N3416 transistor	1.00
C4	417-154	4	2N2369 transistor	1.65
C5	417-240	1	40673 transistor	2.40

NOTE: Do not remove the shorting spring from around the leads of each selected 40673 (#417-274) transistor. Leave it in place until you are instructed to remove it.

C6	417-274	2	40673 transistor (selected)	2.30
C7	417-175	2	2N5294 transistor	1.45
C8	442-18	1	MC1350P integrated circuit	2.50
C9	442-28	1	MC13[illegible]P integrated circuit	3.15

HARDWARE

D1	250-52	2	4-40 x 1/4" screw	.05
D2	252-15	2	4-40 nut	.05
D3	254-9	2	#4 lockwasher	.05

CRYSTALS

D4	404-535	2	10.7 MHz crystal filter	6.55
D5	404-537	1	10.245 MHz	4.55
D6	404-538	1	R146.94 (45.4133 MHz)	5.10

MISCELLANEOUS

E1	432-121	23	PCB pin (3 extra)	.15
E2	432-134	14	Wire socket (2 extra)	.15
E3	434-225	1	IC socket	.25
E4	475-10	6	Ferrite bead	.15
E5	346-6	1	Fiber sleeving	.05

PART FROM PACK #5

	85-1382-2	1	Receiver circuit board	6.15

NOTE: See Page 112 for "Replacement Parts and Price Information."

TRANSMITTER CIRCUIT BOARD

PARTS LIST

Remove the parts from pack #4 and check each part against the following list. The key numbers correspond to the numbers on the Parts Pictorial (fold-out from Page 44).

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
RESISTORS				
A1	1-130	1	8.2 Ω, 5% (gray-red-gold-gold)	.15
A1	1-49	1	22 Ω (red-red-black)	.15
A1	1-103	1	33 Ω (orange-orange-black)	.15
A1	1-83	1	56 Ω, 5% (green-blue-black-gold)	.15
A1	1-118	1	82 Ω (gray-red-black)	.15
A1	1-3	1	100 Ω (brown-black-brown)	.15
A1	1-66	1	150 Ω (brown-green-brown)	.15
A1	1-4	1	330 Ω (orange-orange-brown)	.15
A1	1-7	2	680 Ω (blue-gray-brown)	.15
A1	1-9	2	1000 Ω (brown-black-red)	.15
A1	1-11	1	1500 Ω (brown-green-red)	.15
A1	1-93	7	1800 Ω (brown-gray-red)	.15
A1	1-16	1	4700 Ω (yellow-violet-red)	.15
A1	1-18	1	5600 Ω (green-blue-red)	.15

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
Resistors (cont'd.)				
A1	1-20	1	10 kΩ (brown-black-orange)	.15
A1	1-133	5	15 kΩ, 5% (brown-green-orange-gold)	.15
A1	1-69	1	18 kΩ (brown-gray-orange)	.15
A1	1-132	1	20 kΩ, 5% (red-black-orange-gold)	.15
A1	1-22	2	22 kΩ (red-red-orange)	.15
A1	1-24	1	33 kΩ (orange-orange-orange)	.15
A1	1-67	2	39 kΩ (orange-white-orange)	.15
A1	1-25	4	47 kΩ (yellow-violet-orange)	.15
A1	1-159	1	82 kΩ, 5% (gray-red-orange-gold)	.15
A1	1-26	7	100 kΩ (brown-black-yellow)	.15
A1	1-27	1	150 kΩ (brown-green-yellow)	.15
A1	1-35	1	1 MΩ (brown-black-green)	.15
A1	1-86	1	5.6 MΩ (green-blue-green)	.15

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
CAPACITORS				
Mica				
A2	20-130	1	12 pF	.25
A2	20-99	1	22 pF	.25
A2	20-100	1	30 pF	.25
A2	20-96	1	36 pF	.25
A2	20-108	1	200 pF	.30
A2	20-120	1	220 pF	.30
A2	20-125	1	240 pF	.30
A2	20-114	2	270 pF	.30
A2	20-115	1	300 pF	.40
A2	20-106	3	390 pF	.45
A2	20-107	1	680 pF	.60
Disc				
A3	21-33	2	3.3 pF	.15
A3	21-3	1	10 pF	.15
A3	21-61	1	6.8 pF	.15
A3	21-60	7	18 pF	.15
A3	21-6	6	27 pF	.15
A3	21-155	1	33 pF	.15
A3	21-167	3	39 pF	.15
A3	21-160	1	56 pF	.15
A3	21-161	2	82 pF	.15
A3	21-162	1	180 pF	.15
A3	21-17	1	270 pF	.15
A3	21-56	2	470 pF	.15
A3	21-159	1	510 pF	.25
A3	21-163	6	.001 μF	.15
A3	21-164	1	.0015 μF	.15
A3	21-173	1	.0022 μF (2200)	.25
A3	21-26	6	.003 μF	.15
A3	21-154	5	.0051 μF	.15
Others				
A4	25-221	2	2.2 μF tantalum	.60
A5	27-42	1	6800 pF Mylar* (.0068)	.25
A6	27-74	2	.01 μF Mylar (.01K100)	.15
A6	27-73	1	.047 μF Mylar (047K100)	.25
A7	28-2	2	1 pF phenolic (brown-black-white-silver)	.15
A7	28-3	1	.56 pF phenolic (green-blue-gray-silver)	.15
A8	31-57	6	Trimmer	1.05
COILS-CHOKES				
B1	40-947	1	24 μH coil (2-lug large red)	1.35

*Dupont Registered Trademark.

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
Coils-Chokes (cont'd.)				
B2	40-948	2	1.16 μH coil (4-lug)	1.00
B3	40-949	2	.72 μH coil (6-lug)	1.30
B4	40-1631	1	.25 μH coil (2-lug, small red)	1.00
B4	40-1632	1	.104 μH coil (yellow)	1.00
B4	40-1633	2	.07 μH coil (blue)	1.00
B5	45-38	1	.295 μH choke	1.00
B5	45-39	3	4.65 μH choke	1.00
DIODES				
B6	56-49	1	MV1638 variable capacity diode	4.30
B7	56-56	7	1N4149 diode	.30
TRANSISTORS				

NOTE: Transistors are marked for identification in one of the following four ways:

1. Part number.
2. Type number.
3. Part number and type number.
4. Part number with a type number other than the one listed.

C1	417-118	3	2N3393	.40
C2	417-169	1	MPF105	1.50
C3	417-93	3	2N3646	1.40
C4	417-154	2	2N2369	1.65
C5	417-205	1	2N3866	5.00
MISCELLANEOUS				
D1	10-312	1	10 kΩ control	1.00
D2	206-444	5	Coil shield	.35
D3	404-540	1	6122.5 kHz crystal (T146.94 MHz)	5.25
D4	432-120	1	PCB connector	.15
D5	432-121	22	PCB pin	.15
D6	432-134	12	Wire socket	.15
D7	475-10	3	Small ferrite bead	.15
D8	475-12	1	Large ferrite bead	.25
PART FROM PACK #5				
	85-1491-1	1	Transmitter circuit board	5.75

NOTE: See Page 112 for "Replacement Parts and Price Information."

CHASSIS

PARTS LIST

Check all the remaining parts (pack #5) against the following list. The key numbers correspond to the numbers on the Chassis Parts Pictorial (fold-out from Page 57).

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
RESISTORS-CAPACITORS-DIODE				
A1	1-20-2	2	100 Ω, 2-watt (brown-black-brown) resistor	.20
A2	1-62	1	51 Ω, 5% (green-brown-black-gold) resistor	.15
A3	21-56	12	470 pF disc capacitor	.15
A3	21-47	1	.01 μF disc	.15
A4	56-55	1	Zener diode (30 V)	1.50
CONTROLS-SWITCH				
B1	10-227	1	2000 Ω (2 k) control	1.35
B2	19-179	1	10 kΩ control with switch	2.05
B3	64-612	2	Switch assembly	5.40

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
METAL PARTS				
C1	90-577-2	1	Cabinet	5.00
C2	90-583-1	1	Bottom plate	4.70
C3	200-651	1	Chassis	6.15
C4	203-1467-1	1	Front panel	2.35
C5	203-1468-1	1	Front subpanel	1.75
C6	204-1865-2	1	Gimbal bracket	3.60
C7	204-1866-2	1	Gimbal plate	2.55
C8	205-1413	2	Switch spacer	.40
C9	205-1423	1	Crystal retainer	.45
C10	210-58	1	Bezel	3.40
C11	215-67	2	Heat sink	.75

HARDWARE

#6 Hardware

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
D1	250-138	6	6-32 x 3/16" screw	.05
D2	250-56	7	6-32 x 1/4" screw	.05
D3	250-432	6	6-32 x 5/16" truss head screw	.05
D4	250-237	2	#6 x 3/8" sheet metal screw	.05
D5	250-434	5	6-32 x 3/8" flat head screw	.05
D6	250-162	1	6-32 x 1/2" screw	.05
D7	254-1	37	#6 lockwasher	.05
D8	259-1	3	#6 solder lug	.05
D9	252-3	23	6-32 nut	.05
D10	250-1158	4	6-32 x 3/4" stud	.05
D11	255-71	1	6-32 x 3/4" spacer	.35
D12	255-60	2	6-32 x 1-1/8" spacer	.20

#10 Hardware

E1	250-83	4	#10 x 1/2" sheet metal screw	.05
E2	253-19	2	#10 flat washer	.05
E3	250-1147	2	#10 thumbscrew	.50
E4	252-49	2	#10 thumbnut	.45

Control Hardware

E5	253-10	2	Control flat washer	.05
E6	253-15	2	Control black fiber washer	.05
E7	254-5	3	Control lockwasher	.05
E8	252-7	2	Control nut	.05

Other Hardware

F1	250-433	4	#4 x 3/4" black Phillips head sheet metal screw	.05
F2	252-50	4	#4 Speed Nut	.05
F3	259-24	2	#8 solder lug	.05
F4	253-105	3	7/8" flat washer	.05
F5	253-91	2	1" cork washer	.10

CONNECTORS

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
G1	432-38	1	Microphone connector	1.35
G2	432-39	1	Microphone jack	1.15
G3	432-720	1	Female connector housing	.20
G4	432-723	2	Male connector housing	.20
G5	432-72	2	Male connector (large)	.15
G6	432-73	4	Female connector	.15
G7	490-112	1	Extractor tool	.55
G8	432-120	33	PCB connector	.15
G9	432-183	1	9-pin plug housing	.20
G10	438-4	1	Phono plug	.15
G11	432-137	1	Push-on connector	.15
G12	259-22	1	Spade lug	.05
G13	260-58	1	Black battery clip	.45
G13	260-59	1	Red battery clip	.45
G5	432-152	9	Male connector (small)	.15

GENERAL

H1	475-10	9	Ferrite bead	.15
H2	75-24	1	Strain relief	.15
H3	421-32	1	5-ampere, 3AG, fuse	.25
H4	423-10	1	Fuseholder assembly	.75
H5	407-167	1	Meter	5.65
H6	401-167	1	Speaker	4.80
	480-63	1	Microphone with clip	14.20
	75-193	2	Insulating paper	.45

MISCELLANEOUS

J1	73-3	1	1/2" grommet	.15
J2	261-29	8	Foot	.05
J3	462-291	2	Knob	.95
J4	266-295	1	Panel insert	1.05
J5	205-778	1	1" steel blade	.15
	73-39	1	Foam tape	.15
	390-998	2	Black on silver label set	.55
	390-999	2	Silver on black label set	.55

NOTE: See Page 112 for "Replacement Parts and Price Information."

CIRCUIT DESCRIPTION

efer to the Schematic Diagram (fold-out from Page 133) hile you read this "Circuit Description." The part numbers the Schematic are arranged in the following groups to lp you locate specific parts on the Schematic, chassis, and cuit boards:

100-199 1101-1199	Parts mounted on the Receiver circuit board.
200-299	Parts mounted on the Transmitter circuit board.
300-399	Parts mounted on the Power Amplifier circuit board.
400-499	Parts mounted on the Hash Filter/Regulator circuit board.
500-599	Parts mounted on the chassis.

HANNEL SELECTION (Figure 4-1)

ne transmit and one receive Channel Selector button must pushed IN to operate the Transceiver. Each button ntrols two channels, selected by the position of the I-OUT button. Thus, six receive and six transmit channels e possible. This description discusses one receive channel. l other channel selection circuits are similar.

pushbutton switch SW506 is OUT (see Figure 4-1A), no ound path is available to point A through resistor R131. onsequently, full supply voltage is applied to the cathode D101, which is therefore back-biased (as there is only 3.9 lts on its anode) and it does not conduct. Thus Y101, 101, Y102, and L102 are isolated from oscillator transistor 116.

hen SW506 is pushed IN (Figure 4-1B), a virtual ground is tablished for point A through contacts 2 and 3, and switch W509. This ground connection causes the voltage at point to drop to approximately one volt, which causes diode 101 to be forward biased (1 volt on its cathode and 3.9 lts on its anode) and it conducts. This connects crystal 101 and coil L101 to the base of Q116 to complete the rcuit of the first oscillator.

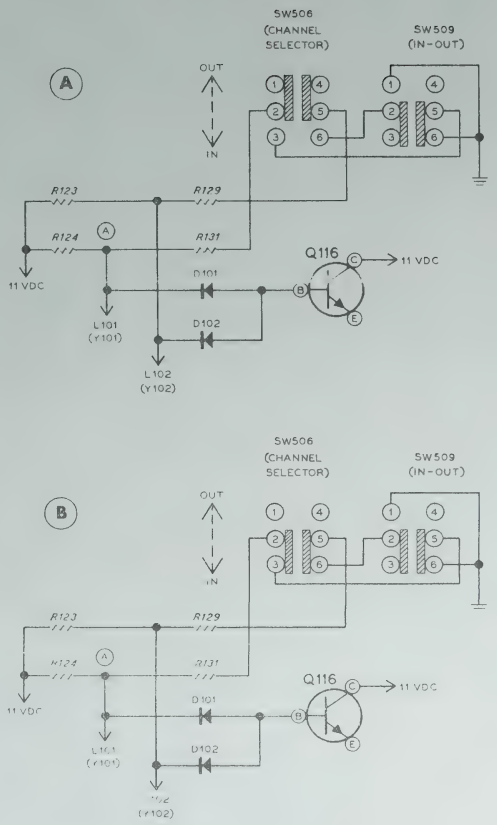


Figure 4-1

Figure 4-1 shows that when SW506 is IN, either Y101 or Y102 can be switched into the oscillator circuit. This depends upon the IN or OUT position of SW509.

RECEIVER

First Oscillator

Transistor Q116 and its associated components form a third overtone oscillator operating in the region of 45 MHz. The signal is coupled through capacitor C112 to the base of frequency tripler transistor Q117. The output circuits of Q117 are tuned to a frequency of three times that of the oscillator. Thus, the signal coupled through capacitor C116 to the base of amplifier transistor Q118 is approximately 135 MHz. This frequency is tuned by oscillator coil L101 to exactly 10.7 MHz below that of the incoming signal. The amplified signal from the collector of transistor Q118 is then coupled through C121 to mixer transistor Q102.

RF Circuits

The signal from the antenna is coupled into gate G_1 of the RF amplifier, MOSFET* Q101, where it is amplified. The output of Q101 is routed through a double-tuned circuit consisting of L109, L110, and associated capacitors, C137 and C138. The bandwidth of the signal applied to gate G_1 of Q102 (also a dual gate MOSFET) is approximately 1.5 MHz at 6 dB down on the response curve. The input to gate G_2 of Q102 is the amplified first oscillator signal. The incoming signal and the amplified oscillator signal are mixed in Q102 and the output is coupled through circuits which filter all frequencies except 10.7 MHz.

The 10.7 MHz first IF signal is passed through two double-pole crystal filters, FL101 and FL102 which have a combined bandwidth of 22 kHz. Input and output transformers T101 and T102 are sealed components. The signal is coupled to pin 4 of IC101 through capacitor C148. IC101 amplifies the signal. This amplified 10.7 MHz signal is coupled across filter transformer T103 and through C156 to gate G_1 of MOSFET Q103.

Transistor Q103 is a dual-gate MOSFET second mixer stage. A second oscillator circuit, consisting of crystal Y107 and transistor Q104, generates a signal at 10.245 MHz. This signal is mixed in transistor Q103 with the incoming 10.7 MHz signal and a second IF signal of 455 kHz is produced. This signal is coupled through IF transformer T104 which not only provides 455 kHz selectivity but also provides impedance matching to the input of the 2nd IF amplifier, IC102.

Part of the received signal is coupled by C167 to the metering and AGC circuits. Diode D112 rectifies the signal and passes it to Q120, which is DC coupled to Q119. These two transistors amplify the DC voltage and apply it as a DC bias to pin 5 of IC101 to reduce its gain.

*Metal Oxide Semiconductor Field Effect Transistor

SECOND IF AMPLIFIER – QUADRATURE DETECTOR

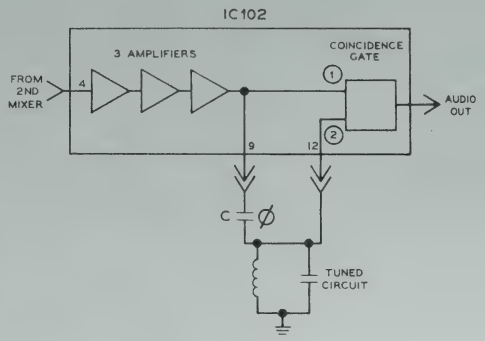


Figure 4-2

A block diagram of IC102, and associated circuitry, is shown in Figure 4-2. In the following simplified description, the input from the 2nd Mixer is passed through three amplifiers and an associated tuned circuit to a coincidence detector. The output from the detector is an audio signal.

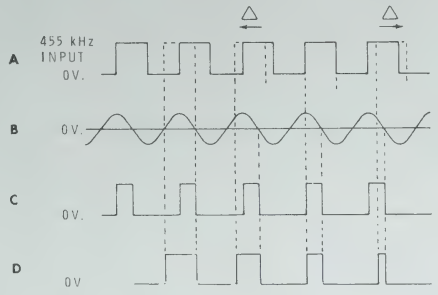


Figure 4-3

In Figure 4-3, the horizontal denotes time and the vertical represents voltage.

Waveform A shows the 455 kHz carrier input to IC102. Capacitor C (in Figure 4-2) couples some of the energy from the carrier pulses into the tuned circuit, which is resonant at 455 kHz. The tuned circuit has the "flywheel effect" of a tank circuit so its output, and the input to 2 of Figure 4-2, approximates waveform B. Because of the phase shift in capacitor C, the maximum voltage points of waveform B occur during the leading edge transitions of waveform A.

The dotted lines superimposed on waveform A represent a frequency displacement of the carrier with modulation. The tank circuit, however, continues at its resonant frequency and waveform B does not change frequency.

Waveform C results from the coincidence of postive voltages in waveforms A and B when the carrier only is present. When waveform A is displaced in frequency by modulation, as represented by the dotted lines, the positive coincidence of the modulated waveform with waveform B now results in the waveforms at D. Note that these waveforms vary in width, controlled by the modulation of the carrier. Waveform D, when integrated (averaged), is the audio output voltage.

As the signal voltage leaves IC102, it is routed into two paths. The first is through a de-emphasis network consisting of C177, R159, C182, and R161. Then it goes through coupling capacitor C183 to the base of transistor Q108. The purpose of the de-emphasis network is to remove the pre-emphasis that was applied in the transmitter. NOTE: Both pre-emphasis and de-emphasis curves follow an industry standard.

The second path from IC102 is through capacitor C178 which tends to pass only high audio frequencies. In addition, a series-tuned network consisting of C179 and RFC103 keeps voice frequencies from breaking the squelch. At this point, in the absence of a signal, a clean, high-level noise is present. This noise is amplified by transistors Q105 and Q106, and rectified in a voltage doubler circuit consisting of diodes D108 and D109. It is then filtered and coupled to the base of transistor Q107.

When no signal is present in the circuit, the rectified and amplified noise causes current through Q107 to increase. Therefore the voltage drop across R178, the common emitter resistor of both Q107 and Q108, will increase. At a predetermined threshold, this current will cause Q108 to cut off and "squelch" its output.

When audio signals are present, the voltage at the base of Q107 drops to near zero and the current through its emitter resistor, R178, also drops. This permits Q108 to pass voice signals, or to be "unsquelched."

The audio amplifier circuits of transistors Q109 through Q115 are quasi-complementary. The output of this circuit is routed through J501 to connector P301 on the power amplifier, and from there to either an internal or an external speaker. (In the transmit mode, the audio output is grounded by relay contacts 7 and 11.)

TRANSMITTER

NOTE: To transmit the necessary audio information within the FCC limitations, a system known as pre-emphasis and de-emphasis is used. This system is the nonlinear amplification of a band of audio frequencies so they will conform to the deviation regulations.

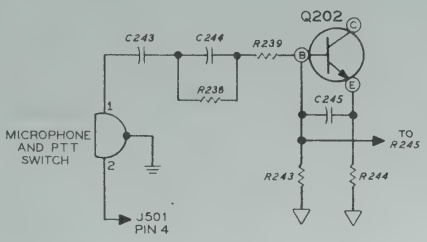


Figure 4-4

Transmitter Circuit Board

The audio signal from the microphone is coupled to the transmitter circuit board, where it is applied across a pre-emphasis network as shown in Figure 4-4. Here it receives a 6 dB-per-octave pre-emphasis. Capacitors C243 and C244 are of a low value and allow the high frequencies to pass more easily than the lower frequencies. Thus, the higher frequencies are effectively amplified more than the lower frequencies, and the pre-emphasis is achieved as shown in the graph of Figure 4-5, where line B is an audio signal of larger amplitude than line A.

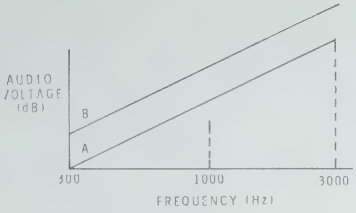


Figure 4-5

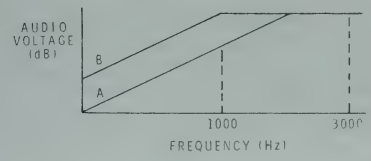


Figure 4-6

From the pre-emphasis network, the signal passes through amplifier stage Q202 and grounded-emitter transistors Q203 and Q204. These last two stages limit signals of normal strength. The output of Q204 is a 10-volt peak-to-peak square wave, with the high frequencies being limited before the lower frequencies, as shown in Figure 4-6.

The square-wave output from Q204 is applied through the deviation control, and through a stage of de-emphasis as shown in Figure 4-7, to a post-limiter roll-off network. This de-emphasis is shown graphically in Figure 4-8. The post-limiter roll-off network greatly attenuates signals over 3000 Hz as indicated by Y. Consequently, the signal that is coupled from the roll-off network to modulator diode D207 and coil L201 approximates a sine wave. The phase modulator inherently pre-emphasizes the signal 6 dB per octave, as shown in Figure 4-9. The signal remains pre-emphasized until it reaches the audio circuits in the receiver.

NOTE: The receiver de-emphasis circuit is very similar to the de-emphasis circuit shown in Figure 4-7. The low frequency signals are, in effect, amplified more than the high frequency signals. Thus, the audio from the receiver is very similar to the audio going into the transmitter.

Modulator diode D207 also receives the signal from the transmitter oscillator circuit, where the channel selector button supplies a ground to the selected transmitter crystal circuitry. This permits the crystal to operate with oscillator transistor Q201. Compensating capacitors are used to temperature compensate each of the six transmitter crystals. The oscillator output is coupled to L201 which, with its associated circuitry, resonates at approximately 6.1 MHz.

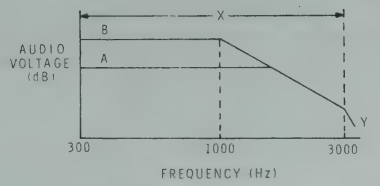


Figure 4-8

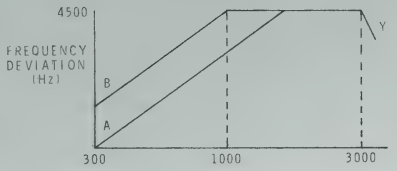


Figure 4-9

Diode D207 is a back-biased variable capacitance diode. The audio signal from the roll-off network and Q204 varies the capacitance of the diode junction of D207 at an audio rate and a phase-modulated signal results.

From D207 the modulated signal is amplified by transistor Q205 and is then applied to Q206 which triples the frequency. The signal from Q206 is doubled in Q207, and then coupled to Q208, a JFET (junction field-effect transistor) frequency doubler stage. The output of Q208 is coupled to transistor Q209, a doubler. After having passed through the previous tripler and doubler stages, the original 6.1 MHz signal is at approximately 146 MHz at Q209. Transistor Q210 is an amplifier circuit which raises the level of the signal to drive the power amplifier. The minimum power is over 100 milliwatts and the circuit impedance at the output is 50 ohms.

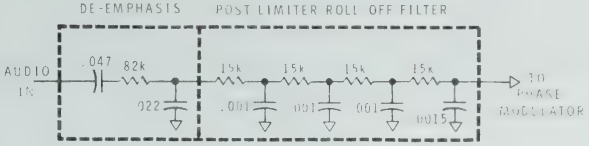


Figure 4-7

Note that throughout the transmitter multiplier string there are six test points (TP). TP's 101 through 105 measure the emitter current at successive stages. (In effect, the amount of drive at each point can be measured at TP101 through TP105.) TP106 is a point at which the drive or output of the entire transmitter multiplier string can be measured.

A shielded cable carries the 146 MHz signal from the transmitter circuit board to the power amplifier circuit board.

POWER AMPLIFIER CIRCUIT BOARD

The impedance of the signal from the transmitter is matched at the input of the power amplifier circuit by C301, C302, and L301, a printed circuit board coil. The base of Q301 is grounded for DC, which causes this transistor to operate Class C. The base is raised above ground for RF by a low-Q inductance formed by ferrite bead FB301.

Interstage coupling between amplifier transistors Q301 and Q302 is similar to that of the input circuit. It matches the impedance of the two stages. This circuit consists of C303, C304, C305, and L302, another printed coil. This transistor operates Class C in the same manner as Q301.

Impedance matching at the output of Q302 to the 50 ohms required at the antenna is accomplished in the circuit consisting of L303, C308, and C311. A low pass filter is also in the output circuit of Q302. This consists of capacitors C313, C315, and C316, and of coils L304 and L305.

The output signal is routed through relay K301 to the output of the Transceiver, where it is connected to the antenna.

Relay K301

In the receive mode, the relay coil is not grounded and the relay remains inactivated. In this condition, the antenna is connected to the input of the receiver through contacts 12 and 4. The regulated 11 volts DC is connected to the receiver circuits through contacts 9 and 1, the 13.8 VDC is routed to the receiver through contacts 10 and 2, and relay contacts 11 and 7 are open and permit the speaker to function. The receive audio may be switched from the internal speaker to an external speaker, at the operator's option, by SW301 on the power amplifier circuit board.

When the microphone PTT switch is depressed, the transmitter circuits are enabled by relay K301 in the following manner: The PPT switch grounds one end of the relay coil and energizes it. Contacts 9 and 5 route the regulated 11-volt DC supply to the transmitter circuits, contacts 10 and 6 connect the 13.8-volt supply to the transmitter, the receiver audio is grounded through relay contacts 11 and 7, and the output of the power amplifier is connected to the antenna through contacts 8 and 12. Zener diode D501 at the microphone jack is used to eliminate switching transients from the relay coil line.

S Meter

The S Meter gives a relative power indication when the Transceiver is in the transmit mode. Some of the output of Q302 on the power amplifier circuit board is coupled through C312 to D301, where it is rectified. The voltage is filtered by R301 and C314, and then connected to the positive terminal of the S-meter.

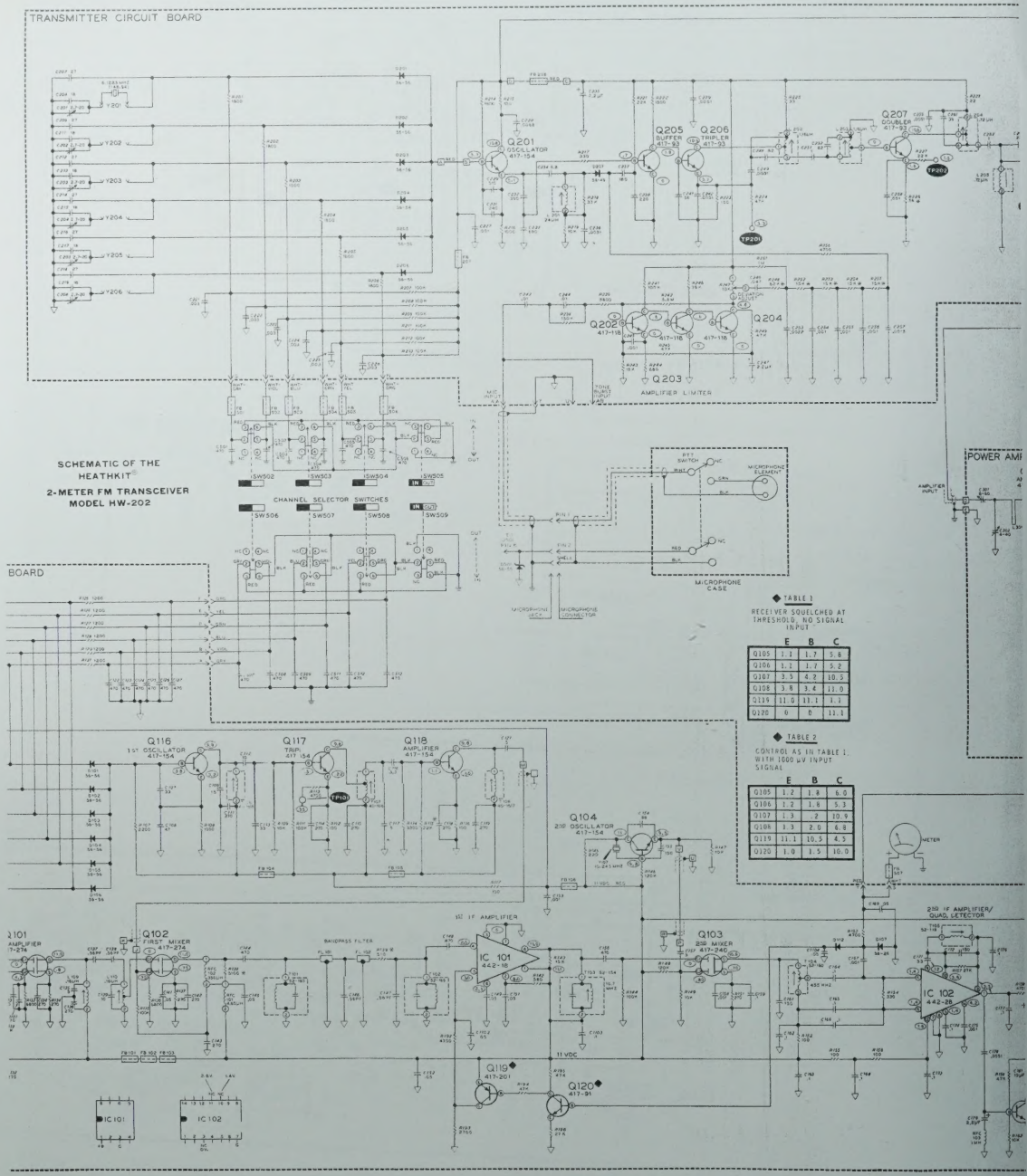
In the receive mode, signal voltage is coupled by C167 from the output of T104 on the receiver circuit board to D107 where it is rectified, filtered by R153 and C169, and then connected to the positive S-meter terminal.

Hash Filter/Regulator

The line coming from the power source is filtered by C401, C402, C403, and RFC401 to eliminate noise from the line.

The Transceiver is protected against reversed polarity by diode D401. As long as the polarity is correct, D401 is back-biased and will not conduct. Should the power connections be reversed, the diode will be forward-biased and will short circuit the power source. This will blow the fuse and thus protect the Transceiver.

Q401 is a series regulator transistor whose output is 11 volts DC. R401 limits the current through zener diode D402 to a safe value. C405, C406, and R402 filter VHF noise from the diode. The output voltage is equal to the zener voltage, less the drop across the emitter-base junction of Q401. If the unregulated DC input voltage increases or decreases, the voltage across D402 will remain constant as the zener current changes, thus maintaining the voltage at which the zener regulates. There is no short circuit protection in this regulator; a prolonged short circuit may cause damage to the components.



◆ TABLE 1

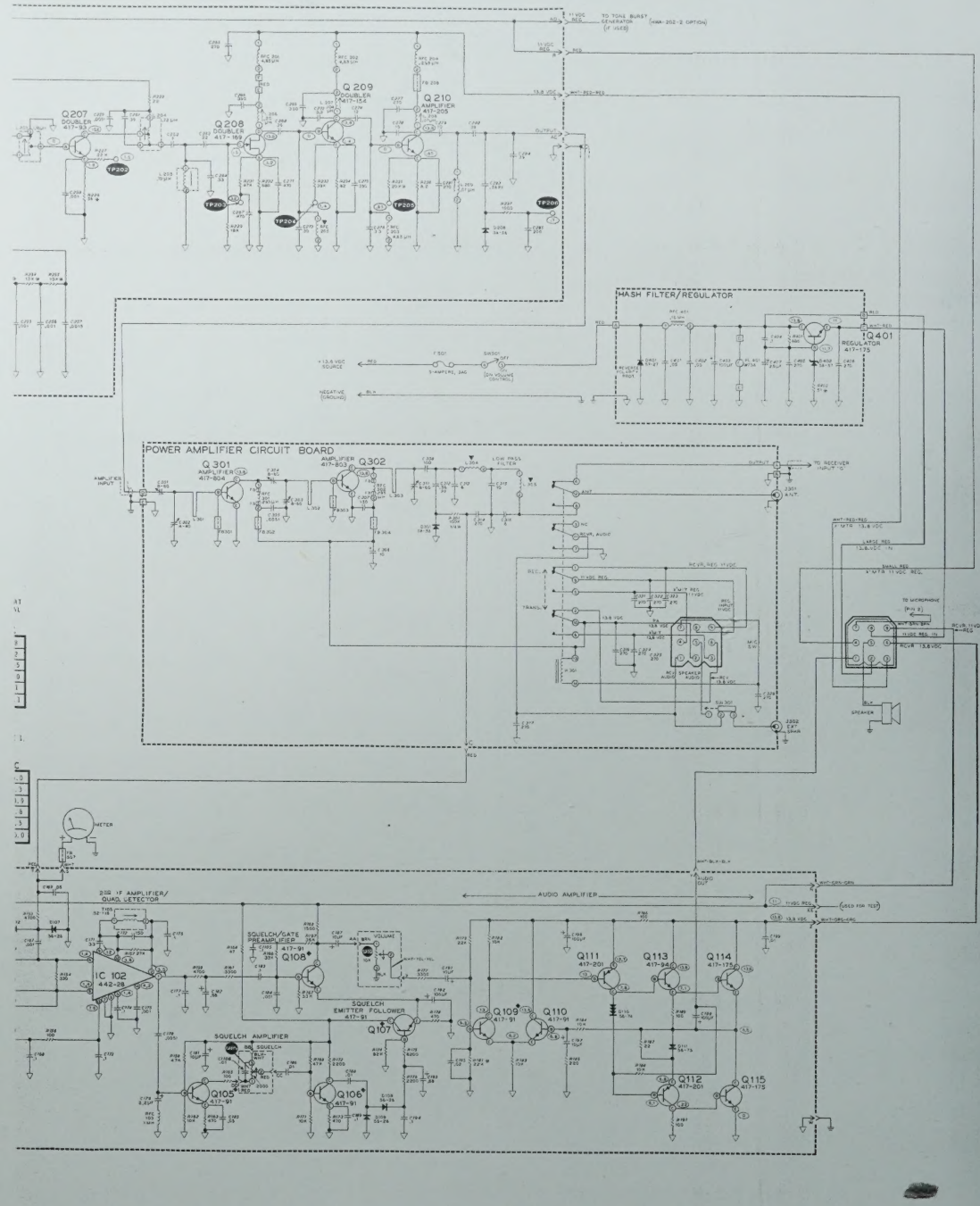
RECEIVER SQUELCHED AT THRESHOLD, NO SIGNAL INPUT

	E	B	C
Q105	1.1	1.7	5.8
Q106	1.1	1.7	5.2
Q107	3.5	4.2	10.5
Q108	3.8	3.4	11.0
Q119	11.0	11.1	1.1
Q120	0	0	11.1

◆ TABLE 2

CONTROL AS IN TABLE 1, WITH 1000 µV INPUT SIGNAL

	E	B	C
Q105	1.2	1.8	6.0
Q106	1.2	1.8	5.3
Q107	1.3	.2	10.9
Q108	1.3	2.0	6.8
Q119	11.1	10.5	4.5
Q120	1.0	1.5	10.0


Q207 DOUBLER 417-93
Q208 DOUBLER 417-169
Q209 DOUBLER 417-156
Q210 AMPLIFIER 417-205
TP200
TP201
TP202
TP203
TP204
WASH FILTER/REGULATOR
Q401 REGULATOR 417-175
POWER AMPLIFIER CIRCUIT BOARD
Q301 AMPLIFIER 417-804
Q302 AMPLIFIER 417-803
LOW PASS FILTER
TO RECEIVER INPUT "O"
TO MICROPHONE
SPEAKER
+13.6 VDC SOURCE
NEGATIVE (GROUND)
3-AMPERE, 3AG
ON/VOLUME CONTROL
METER
2ND IF AMPLIFIER/ QUAD. DETECTOR
IC 102 442-28
SQUELCH/GATE PREAMPLIFIER
Q108 417-91
SQUELCH EMITTER FOLLOWER 417-91
Q107
SQUELCH AMPLIFIER
Q105 417-91
Q106 417-91
AUDIO AMPLIFIER
Q109 417-91
Q110 417-91
Q111 417-201
Q113 417-94
Q114 417-175
Q112 417-201
Q115 417-175